LONG-TERM CLIMATOLOGICAL EFFECTS ON COASTAL PLANKTON BLOOMS AND RESPONSES OF ASSOCIATED FOOD WEBS

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We used a long-term (15-year), multidisciplinary database in a series of coastal systems of the NE Gulf of Mexico to determine responses of phytoplankton assemblages to natural and anthropogenous nutrient loading from various sources. We also evaluated the effects of plankton blooms on associated food webs. Results from detailed studies in the Perdido drainage system were applicable to various coastal areas along the NE Gulf.

Orthophosphate and ammonia loading by a pulp mill, with associated nutrient gradients as water entered Perdido Bay, were associated with a series of phytoplankton blooms from 1994 to 2001. Initial diatom blooms in the bay in 1994 were replaced with raphidophyte (*Heterosigma akashiwo*) and dinoflagellate (*Prorocentrum minimum*) blooms. These species were statistically associated with deterioration of phytoplankton assemblages, reduced invertebrate and fish populations, and disruptions of bay food webs. Blue green algae blooms (*Merismopedia tenuissima*) in Elevenmile Creek were associated with the recent drought although pulp mill nutrients constituted the probable cause of the blooms. There were statistical associations of reduced biological activity with the *Merismopedia* blooms from 1999 to 2003.

Reductions of nutrient loading by the mill from 2001-2002 resulted in cessation of bay blooms and the start of the recovery of infaunal macroinvertebrates. However, a series of spills from a sewage treatment plant in the upper bay (late 2002, 2003) was associated with increased bloom activity and a collapse of the invertebrate and fish assemblages in major parts of the bay. Wolf Bay, in lower Perdido Bay, was adversely affected by unregulated agricultural runoff from Alabama with the result that no organisms were found in sediments during summer 2003. There were increases in surface and bottom chlorophyll *a*. Extremely low infaunal macroinvertebrate numbers and species richness were noted in lower Perdido Bay during summer 2003, and dead mollusks were found at this time. These data indicated water quality problems in areas receiving runoff from urban areas in lower Perdido Bay that mirrored conditions in Wolf Bay in recent years. Due to nutrient loading from multiple sources, by October 2004, the Perdido Bay system had deteriorated to a point where there was very little in the way of animal life from one end of the system to the other.

Agricultural and urban runoff (non-point sources of nutrients) differed from that associated with point sources (i.e., the pulp mill) in that mill discharges are more or less continuous whereas non-point source effects followed rainfall patterns. The Bayou Marcus Sewage Treatment Facility appeared to represent a hybrid of these forms of runoff, with some nutrient loading during drought periods, and major nutrient loading during periods of heavy rainfall. The experience in Perdido Bay indicated an almost complete lack of regulation of nutrient loading from sewage facilities and non-point sources (agricultural and urban runoff). There has been virtually no effort to view the Perdido system as an interrelated whole, a position that has contributed to the ecological collapse of this once productive estuary.

Application of Perdido findings to Barnegat Bay/Little Egg Harbor and Mullica River Great Bay systems:

Studies in the Barnegat Bay-Little Egg Harbor system in New Jersey (Kennish, 2001) are representative of what is happening in coastal areas throughout the United States. Olsen and Mahoney (2001) describe the association between increased nutrient loading and a continuous series of blooms in the Barnegat system. Brown tides (*Nannochloris atomus* and *Stichococcu*s sp.) constitute a major threat to coastal fisheries in the NE United States. The impacts of such blooms in the Barnegat Bay-Little Egg Harbor system have not been defined. Long-term declines of hard clam resources and submerged aquatic vegetation in the Barnegat Bay-Little Egg Harbor system may reflect the impacts of such blooms, however. In addition, other HAB species such as dinoflagellates (*Prorocentrum lima, P. micans, P. minimum, P. triestinum*) have been noted in the Barnegat system. Blooms of *Dinophysis acumkinata* and *D. acuta* have been noted along with the presence of other toxic species such as *Heterosigma sp., Scripsiella trochoidea* (= *Peridinium trochoideum*), and *Protoperidinium brevipes*. Although these bloom species may have displaced the natural phytoplankton communities, the lack of consistent funding has precluded exact estimates of the impacts of such blooms on the phytoplankton communities of the system. In addition, "many instances of adverse effects of algae, or algal blooms, go unnoticed, unreported, or uninvestigated" (Olsen and Mahoney, 2001). The persistent brown-water conditions that pose a major threat to the Barnegat Bay-Little Egg Harbor system have not been addressed by funding agencies in the region. This situation is common in most of the coastal areas of the U. S.

There is a need for an integrated, well-funded research effort to determine the following factors in the Barnegat Bay/Little Egg Harbor and Mullica River Great Bay systems.

1. Adequate funding for long-term, interdisciplinary studies of the study area with specific goals that would include determinations of the impacts of anthropogenous nutrient loading in the Barnegat Bay/Little Egg Harbor and Mullica River Great Bay systems.
2. Detailed, long-term nutrient loading analyses in the study area.
3. Associated determinations of species-specific phytoplankton responses to anthropogenous nutrient loading with particular application to seasonal and interannual changes of the system as a response to input from point and non-point sources of nutrients.
4. Integrated analyses of other biological indices based on the response of infaunal and epibenthic macroinvertebrates and fishes to plankton blooms and associated alterations of the phytoplankton community.
5. Determination of long-term changes of food web organization in areas affected by anthropogenous nutrient loading and plankton blooms.
6. Determination of necessary reductions of nutrient loading for restoration of damaged parts of the system.

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